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THE USE OF THE PROTOCOCCACEAE FOR PURIFYING WASTE WATER

(V. N. Yuzvenko)

[Primeneniye protokokkovykh vodorosley dlya ochiski stochnykh vod]

V. N. Yuzvenko

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THE USE OF THE PROTOCOCCACEAE FOR PURIFYING WASTE WATER

V. N. Yuzvenko*

Manufacturing sugar involves the heavy use of pure water and the discharge of a significant amount of category III waste water, which, in its physico-chemical indices, is characterized by high biochemical (BPK_5) and chemical (KhPK) consumption of oxygen, a putrid odor, a lack of dissolved oxygen, and an acid medium. This is caused by the presence of a large amount of organic substances.

The harmfulness of sugar industry waste water is worsened by their content of saponin, which is poisonous for fish, even in small quantities. When such waste water enters public reservoirs without preliminary purification, their normal hydrochemical regime is sharply disrupted. Therefore, category III waste water must obligatorily be purified before discharge into public reservoirs.

At sugar plants of the Ukrainian SSR, filtration fields are used as basic water purification facilities. However, due to the poor filtering capacity of the soil, the filtration fields of many plants have been converted into waste water accumulation fields in which the natural processes of autopurification of water occur very slowly, or not at all.

Liming sugar industry waste water to a certain extent intensifies the natural processes of purification and makes it possible to decrease the biochemical consumption of oxygen to 12-14 mg/l. However, the holding time of waste water reservoirs in the filtration fields reaches 12 months or more, which practically excludes the possibility of timely preparation of the water purifying facilities for the new season.

* The Barsk Base Operational-Experimental Laboratory for Raising and Utilizing Chlorella.

An important measure for sugar plants which have filtration fields with poorly filtering soils is a method of intensifying the natural processes of purifying waste water by the aid of mixtures of Protococcaceae chlorella and cenedesmus, which made it possible for the Barsk Base Operational-Experimental Laboratory for Raising and Utilizing Chlorella to purify and return to repeated use for the sugar industry more than 270 million m^3 of category III waste water.

The method of purifying waste water by the aid of algae is a combination of natural purification processes and artificially conducted measures having the goal of intensifying purification. The measures include liming and algolization of waste water in the charts in filtration fields with subsequent release of the purified water into common use reservoirs.

Waste water is limed to neutralize it, since most of the oxidizing microorganims, including the Protococcaceae algae, that mineralize and purify waste water favor a neutral or mildly alkali medium. Moreover, lime facilitates coagulation of the colloid compounds in the waste water, which enhances sedimentation of the suspended particles.

The liming process must be conducted over the course of the production season such that it terminates no less than 3 months before planting algae in the waste water. As a rule, the optimum condition of liming the waste water is using lime milk and introducing it into the waste water in an irrigation agitator at a water temperature not exceeding 5°C.

By the time of their algolization, well limed waste waters have the following indices: pH — 7.0-8.0; BPK_5 — 200-300 mg/l, KhPK — 200-300 mg/l.

Algolization of waste water is a process of seeding them over the April-June period with a mixture of Protococcaceae chlorella and cenedesmus in the form of paste and suspension. Algolization is conducted so as to create an algae concentration in the waste water of a degree which will practically ensure a predominance of algae of the necessary, earlier selected type over the course of the entire purification period. This is expressed in an accelerated decrease in BPK_5 and KhPK and in the appearance of dissolved oxygen in the waste water.

Algolization of waste water is conducted in 2 stages. First the algae are planted in the waste water of 1 or more reservoirs for primary algolization. After a certain period of time, the algae develop in large numbers in the water (efflorescence of the water begins) and the waste water changes into an algae suspension which must be immediately dispersed into the remaining reservoirs filled with waste water. The second stage of waste water algolization begins at this time.

The table gives the results of algolization of waste water in reservoirs of filtration fields obtained in 1970 at sugar plants of the Vinnitsa, Kiev, and Odessa beet sugar trusts.

The obtained results enable one to draw conclusions concerning the factors that affect the growth of algae in the waste water of filtration field reservoirs. The development of algae in the reservoir waste water prior to the onset of efflorescence of the water corresponds to the exponential law. The general form of the functional relationship between the quantity of newly formed cells and the duration of their formation before the onset of efflorescence of the water can be written as follows:

$$X(t) = X_o e^C,$$

where $X(t)$ — number of living cells per 1 ml waste water prior to the moment of efflorescence of the water;

X_o — value of $X(t)$ at the moment of reservoir algolization;

C — a constant for coefficient for the given reservoir enabling one to take into account the effect of water temperature, pH, depth to which water is filled into the reservoir and amount of nutrients in the waste water.

From the cited data, it follows that the rate of accumulation of algae in the waste water of the reservoirs is significantly affected by water temperature and the depth water is poured into the reservoir. Results obtained at the Bobrovitsk sugar plant are of interest. At that plant, one of the reservoirs was algolized with a suspension, and the other with a paste of algae. Efflorescence of the water was observed in both reservoirs simultaneously, but the content of algae cells per 1 ml waste water upon adding the suspension was 2 times greater then when adding the paste.

Plant	Reservoir characteristic		Indices of water before algolization			Content of algae per 1 ml water, millions of cells	Beginning of efflorescence of water, days from beginning of planting	Method of algolization
	Filling depth, m	waste water vol., thous. m^3	Temperature, °C	pH	BPK_5, mg/l			
Vyshe-Ol'chedayevsk	2.0	4.0	9	7.7	128	6.3	40-e	paste
Kordelevsk	1.5	12.6	15	7.2	103	13.0	11-e	
Bobrovitsk	1.5	10.8	20	7.5	250	7.9	11-e	suspension
Bobrovitsk	1.5	7.2	20	7.8	250	4.2	11-e	paste
Pervomaysk	1.0	3.2	17	7.9	—	9.0	6-e	suspension

By knowing the numerical value of coefficient C and the value of X_o, we can determine the moment of onset of water efflorescence earlier, and consequently, the duration of purification of waste water by the aid of algae in each specific case. One can also, within limits of the accuracy of measurements, draw conclusions regarding the reservoirs filled with waste water and subject to primary algolization, as well as their number in each specific case.

The reservoirs subject to primary algolization must have an area of 0.3-1.2 ha, be filled with waste water to a filling depth of no more than 1.5 m and a volume from 3 to 12,000 m^3. Algolization of waste water must be carried out at a temperature no lower than 15°C and a pH of 7.0-8.0.